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MODAL ANALYSES OF URL-01, URL-02, URL-05 AND URL-06 EXTENDED ENGINEERING CORE SAMPLES FROM THE UNDERGROUND RESEARCH LABORATORY SITE NEAR LAC DU BONNET, MANITOBA

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1.0 INTRODUCTION

Twenty three rock specimens for petrographic analysis were selected from the Extended Engineering Core Samples designated to the Mining Research Laboratories, CANMET, for various mechanical properties measurements. The core samples originated from boreholes URL-01, URL-02, URL-05 and URL-06 at the underground research laboratory site, near Lac du Bonnet, Manitoba.

A number of specimens were selected (from core length ranging from 2.5 cm to 12 cm) from the various boreholes as indicated below:

Borehole	No. of specimens
URL-01	6
URL-02	3
URL-05	7
URL-06	7

Two thin sections on each rock sample were cut in two orientations (i.e., perpendicular and, second parallel to, the core axis). Samples for thin sections were selected adjacent to core samples that were to be used for various geo-mechanical and thermal-mechanical properties investigations associated with the Nuclear Fuel Waste Management Research Program at Mining Research Laboratories, CANMET. At least one of the two thin section samples (specimens) was chemical stained to enable easy identification of K-feldspar. Two thousand points were counted on each thin section to determine the modal volume of the mineral constitutes of the samples. The area of analysis for each thin section was approximately 14 x 28 mm (i.e., 1/3 x 0.6 mm of grid spacing on the mechanical stage).

Only grey granitic rocks (with the exception of two URL-05 pink granite on sample numbers 138.75 and 138.95) were selected for these petrographical studies. The samples were massive, grey to greenish-grey, inequigranular medium to medium-to-coarse grained and consisted of an average mineral composition of 29.4% quartz; 27.6% K-feldspar; 37.1% plagioclase; 3.5% biotite and 2.5% of all other accessory minerals such as muscovite, chlorite, epidote, apatite, magnetite, sphene and sericite etc., (Table 1). This average composition was closely matched with Chernis (1983) values on the URL standard samples.

Sample Number	QZ	KF	PG	BI	MU	CH	EP	AP	MF	OT	Total	Rock Type
URL-01 180.80	31.6	29.6	34.0	3.0	0.5	0.4	0.0	0.1	0.2	0.1	99.5	Granite
URL-01 184.40	30.1	19.6	44.3	3.4	0.8	0.4	0.0	0.1	0.9	0.1	99.7	Granodiorite
URL-01 189.75	29.8	27.2	36.6	3.7	0.5	0.5	0.0	0.8	0.4	0.2	99.7	Granite
URL-01 191.65	23.8	33.4	37.6	3.5	0.8	0.1	0.0	0.1	0.4	0.1	99.8	Granite
URL-01 283.15	28.1	22.5	43.0	3.2	1.1	1.1	0.0	0.1	0.3	0.6	100.0	Granodiorite
URL-01 299.87	25.8	33.9	36.2	1.8	0.7	0.3	0.2	0.2	0.6	0.3	100.0	Granite
Average URL-01	28.2	27.7	38.6	3.1	0.7	0.5	0.0	0.2	0.5	0.2	99.7	
URL-02 1081.16	31.9	29.7	33.7	2.3	0.3	0.4	0.8	0.1	0.7	0.2	100.1	Granite
URL-02 1082.00	25.4	30.9	38.1	3.3	0.4	0.1	0.8	0.2	0.5	0.1	99.8	Granite
URL-02 1082.54	34.7	20.8	38.9	3.8	0.3	0.3	0.4	0.2	0.6	0.1	100.1	Granodiorite
Average URL-02	30.7	27.1	36.9	3.1	0.3	0.3	0.7	0.2	0.6	0.1	100.0	
URL-05 128.17	28.8	31.3	35.0	2.2	1.0	0.4	0.0	0.5	0.5	0.0	99.7	Granite
URL-05 132.65	24.7	45.2	23.9	3.4	0.6	0.4	0.0	0.2	1.0	0.1	99.5	Granite
URL-05 138.74	31.3	26.3	38.0	2.5	0.8	0.6	0.0	0.0	0.6	0.0	100.1	Granite
URL-05 138.95	28.5	27.2	38.5	3.7	0.9	0.4	0.0	0.1	0.5	0.1	99.9	Granite
URL-05 274.89	30.4	26.3	36.5	3.5	1.3	0.9	0.2	0.0	0.6	0.4	100.1	Granite
URL-05 279.00	37.0	34.8	24.8	2.0	0.4	0.1	0.0	0.1	0.4	0.0	99.6	Granite
URL-05 442.82	35.0	28.1	27.3	5.8	0.5	0.3	0.4	0.4	1.3	0.9	100.0	Granite
Average URL-05	30.8	31.3	32.0	3.3	0.8	0.4	0.1	0.2	0.7	0.2	99.8	
URL-06 225.02	30.4	13.5	47.4	5.0	0.9	0.3	0.1	0.5	1.0	0.9	100.0	Granodiorite
URL-06 226.84	23.9	29.9	37.5	6.0	0.7	0.4	0.3	0.3	0.3	0.5	99.8	Granite
URL-06 374.22	28.9	22.5	42.9	3.0	0.7	0.7	0.4	0.3	0.3	0.4	100.1	Granodiorite
URL-06 375.08	28.0	29.0	38.0	2.9	0.7	0.4	0.2	0.2	0.5	0.2	100.1	Granite
URL-06 391.20	29.3	23.6	38.6	5.0	0.7	0.4	0.4	0.8	0.6	0.3	99.7	Granite
URL-06 391.99	29.5	23.5	43.4	1.6	0.3	0.2	0.3	0.2	0.7	0.1	99.8	Granite
URL-06 392.40	28.4	25.4	39.1	5.0	0.5	0.5	0.3	0.5	0.2	0.1	100.0	Granite
Average URL-06	28.3	23.9	41.0	4.1	0.6	0.4	0.3	0.4	0.5	0.4	99.9	
Granite	29.1	29.7	35.5	3.4	0.6	0.4	0.2	0.3	0.6	0.2	100.0	
Granodiorite	30.4	19.8	43.3	3.7	0.8	0.6	0.2	0.2	0.6	0.4	100.0	
Over All	29.4	27.6	37.1	3.5	0.7	0.4	0.2	0.3	0.6	0.3	100.1	

Table 1. Modal analysis of URL-01, URL-02, URL-05 and URL-06 Extended Engineering Standard Core Samples. (Abbreviations: QZ=Quartz, KF=K-feldspar, PG=Plagioclase, BI=Biotite, MU=Muscovite, CH=Chlorite, EP=Epidote, AP=Apatite, MF=Opaques, and OT=Other accessory minerals).

2.0 RESULTS AND GENERAL REMARKS

Two distinct rock group subdivisions (Figure 1) can be identified, based on the classification of Streckeisen (1976) and texture of the rock. The sample numbers URL-01 184.40; URL-01 283.15; URL-02 1082.54; URL-06 225.02 and URL-06 374.22 are classified as granodiorite. The remainder are granite.

The granite is a massive grey to greenish-grey, medium to coarse grained, and consists of an average mineral composition of 29.1% quartz; 29.7% K-feldspar; 35.5% plagioclase; 3.4% biotite and 2.3% of all the other acces- sory minerals (Table 1). Among these granite, two also can be classified as pink granite (i.e., URL-05 138.74 and URL-05 138.95) based on the colour of the rock. However, the mineral composition and texture are similar to those of the grey granites.

The average grain size of the URL-05 grey granite of the three major granitic minerals were as follows: 1.6 x 2.5 mm in quartz;. 2.1 x 3.1 in K-feldspar and 1.7 x 2.2 mm in plagioclase. The phenocrysts of these minerals were also measured: quartz grains of up to 6.5 mm long in sample URL-05 274.89; K-feldspar grains of up to 7.5 mm long in sample URL-05 132.65 and URL-05 138.95 and plagioclase grains of up to 7.8 mm long in sample URL-05 138.95.

The sample on URL-05 442.83 consists of similar mineral composition but with much finer grain size of all the three major minerals (i.e., 0.6 - 0.9 mm in quartz; 0.6 - 0.9 mm in K-feldspar and 0.7 - 0.9 mm in plagioclase). Petrographic analysis indicates high mafic minerals contents (of over 7%) for this sample which may suggest a localized high mafic mineral zone in the vicinity of 442 meters depth.

The five granodiorites were similar in texture to the granites and average composition were: 30.4% quartz; 19.8% K-feldspar; 43.3% plagioclase; 3.7% biotite and 2.8% of all other accessory minerals.

Although there are compositional and textural similarities between the URL- special samples and the Standard Core Samples from the WNRE- site (Kamineni and Dence, 1979; Chernis, 1979; Soles, 1980 and Wong, 1981), the microscopic examination of the URL special samples indicate high incidence of both natural and induced fractures particularly with regard to the quartz grains (Appendix I).

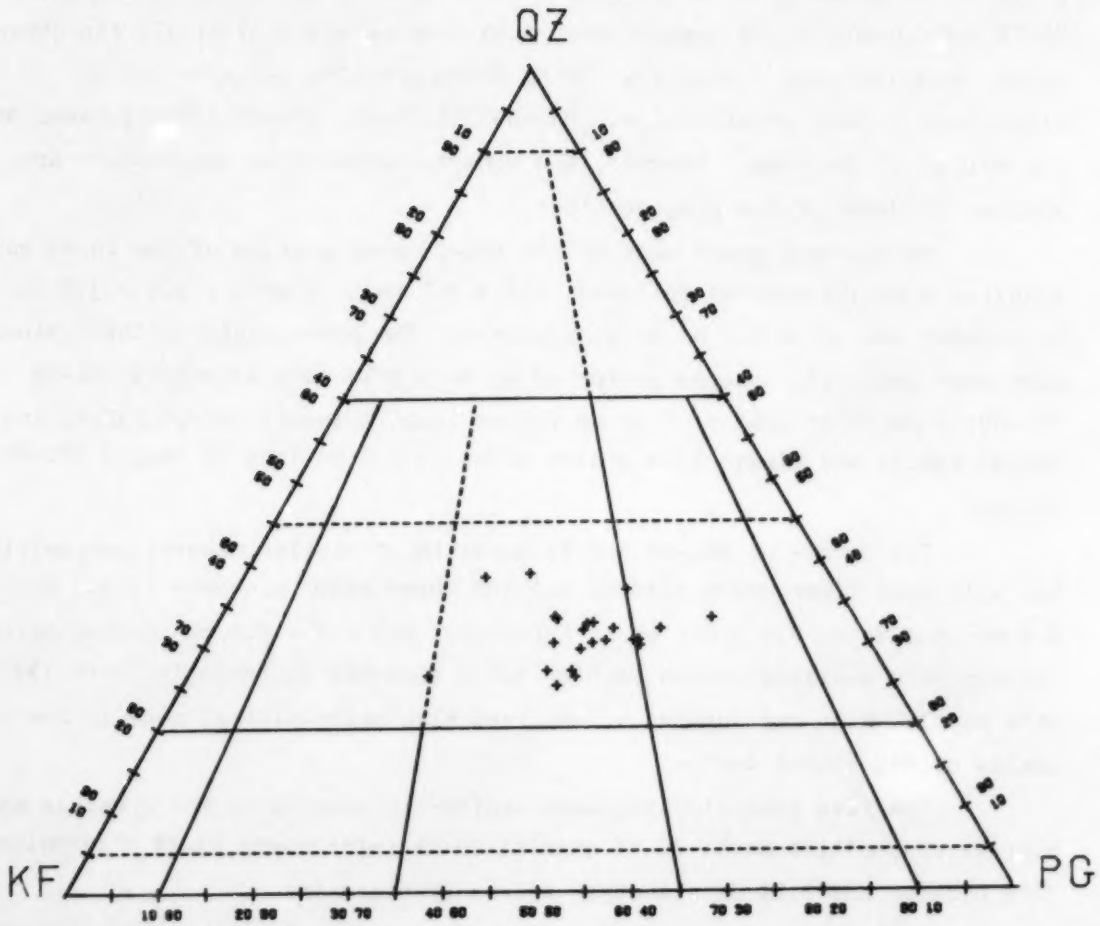

Fig. 1. QAP ternary diagram of modal analyses from boreholes URL-01, URL-02, URL-05 and URL-06. (Q = Quartz, A = K-feldspar and P = Plagioclase,)

3.0 REFERENCES

1. Chernis, P.J. "Modal analyses of URL-2 and URL-5 standard samples"; Technical Data 303415 MO 6/83; Earth Physics Branch, EMR, (1983).

2. Streckeisen, A. "To each plutonic rock its proper name"; Earth-Science Reviews, vol 12, pp 1-33 (1976).

3. Chernis, P.J. "Petrographical analysis of boreholes samples (label-P specimens) from WN1, WN2, CR6 and CR7"; Technical Data, T.D. 7879-T5 (1979).

4. Soles, J.A. "Underground nuclear waste repository studies: petrography and petrofabric of a section of the Pinawa, Manitoba WN1 drill-core"; Division Report No. ERP/MRL 80-131(TR); Mineral Sciences Laboratories, CANMET, EMR, (1980).

5. Wong, A.S. "Petrographic analysis of selected non-standard core samples from borehole WN1, Pinawa, Manitoba"; Division Report No. ERP/MRL 81-140(TR); Mining Research Laboratories, CANMET, EMR, (1981).

4.0 APPENDIX I

(Abbreviations: Q = Quartz, K = K-feldspar and P = Plagioclase,
B = Biotite, M = Muscovite, A = Apatite,
O = Opaque, C = Chlorite, S = Sphene,
(H) = Thin section cut horizontal to core axis or core reference line,
(B) = Thin section cut vertical to core axis).

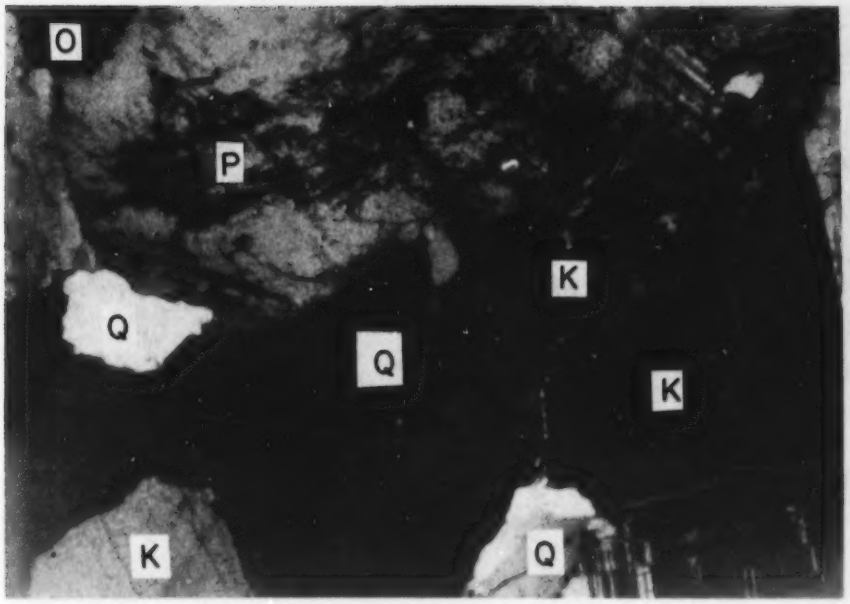

Plate 1. Sample URL-01 180.80 (H). Typical granitic texture of URL rock sample. Crossed nicols. X20.

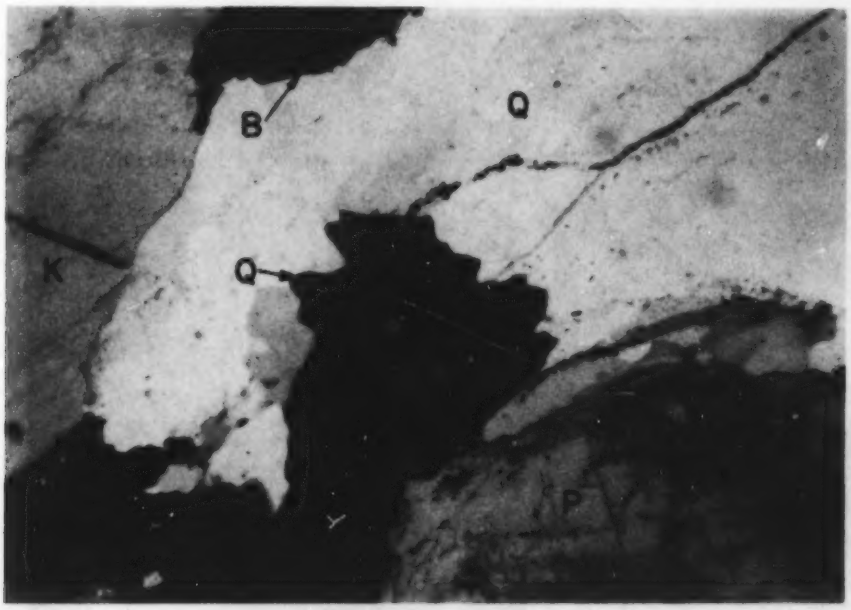

Plate 2. Sample URL-01 180.80 (B). Intragranular fractures and undulatory extinction in quartz. Granitic texture. Crossed nicols. X20.

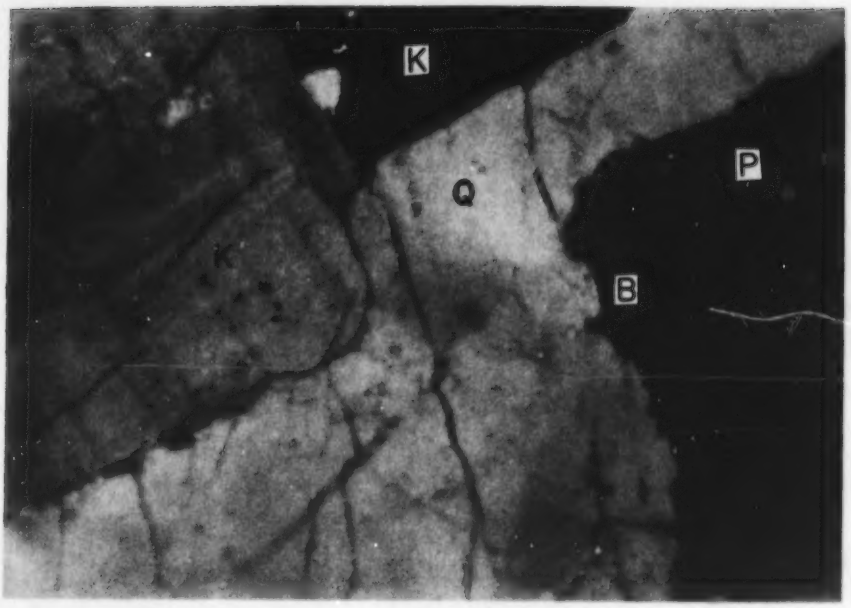

Plate 3. Sample URL-01 184.40 (H). Intragranular fractures in quartz. Typical granitic texture in URL rock sample. Crossed nicols. X20.

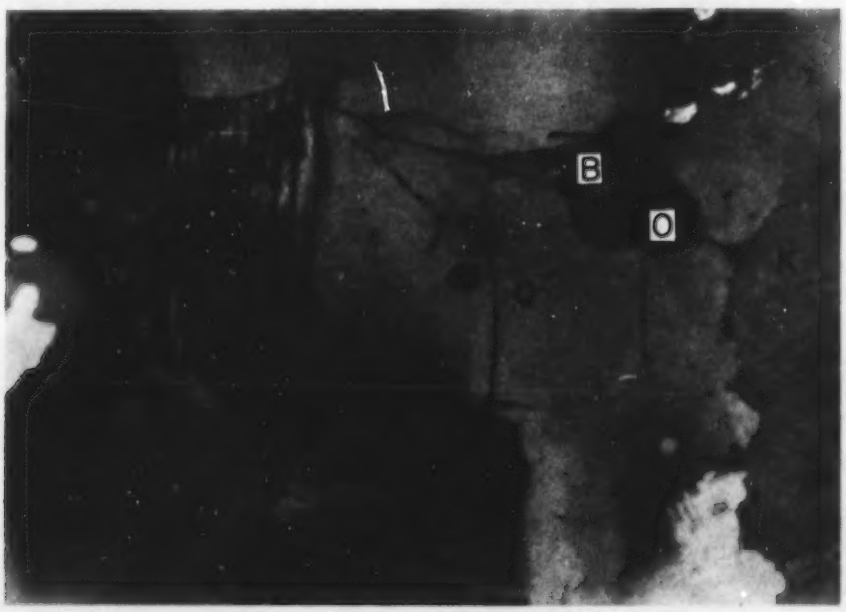

Plate 4. Sample URL-01 184.40 (B). Multiple intragranular fractures and undulatory extinction in quartz. Crossed nicols. X20.

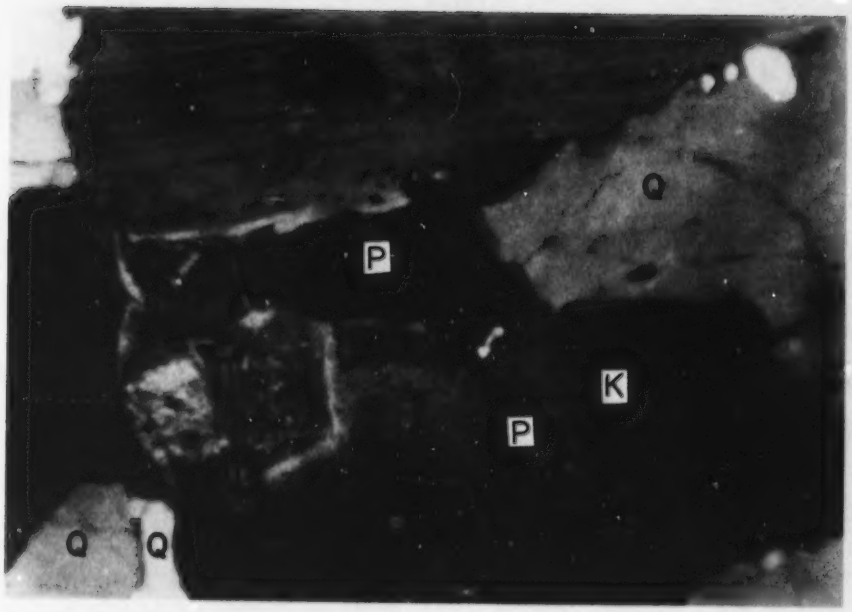

Plate 5. Sample URL-01 189.75 (H). Multiple intergranular fractures that cut through plagiocalse, biotite and magnetite. Crossed nicols. X20.

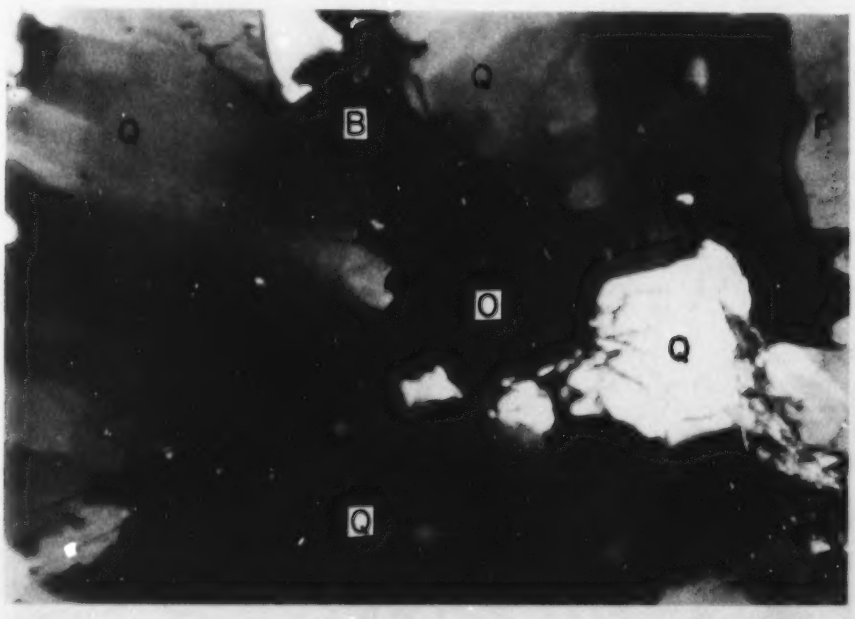

Plate 6. Sample URL-01 189.75 (B). Typical undulatory extinction quartz. Crossed nicols. X20.

Plate 7. Sample URL-01 191.65 (H). Multiple intergranular fractures that cut through quartz, quartz and K-feldspar. Granitic texture. Crossed nicols. X20.

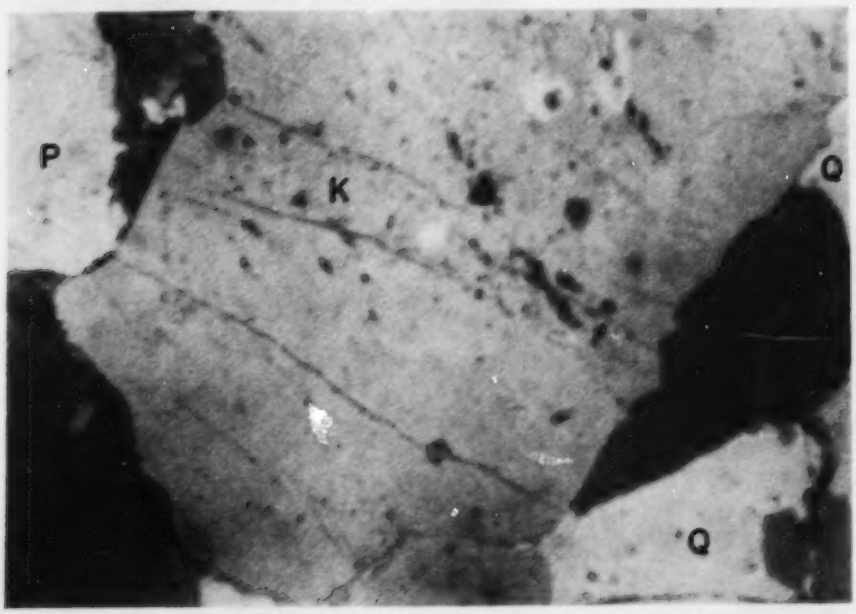

Plate 8. Sample URL-01 191.65 (B). Intragranular and intergranular fractures in K-feldspar. Typical granitic texture. Crossed nicols. X20.

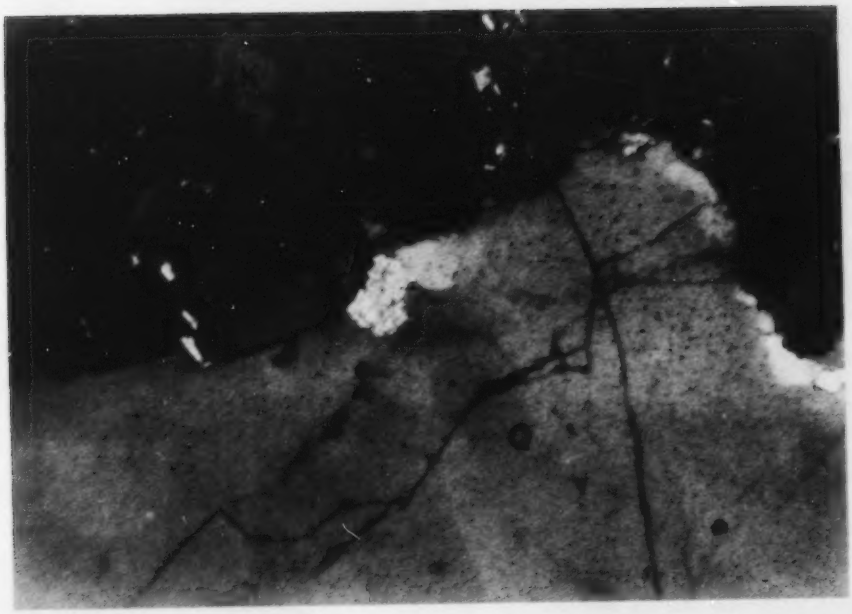

Plate 9. Sample URL-01 283.15 (H). Intergranular fractures that cut through typical undulatory extinction quartz and quartz. Crossed nicols. X20.

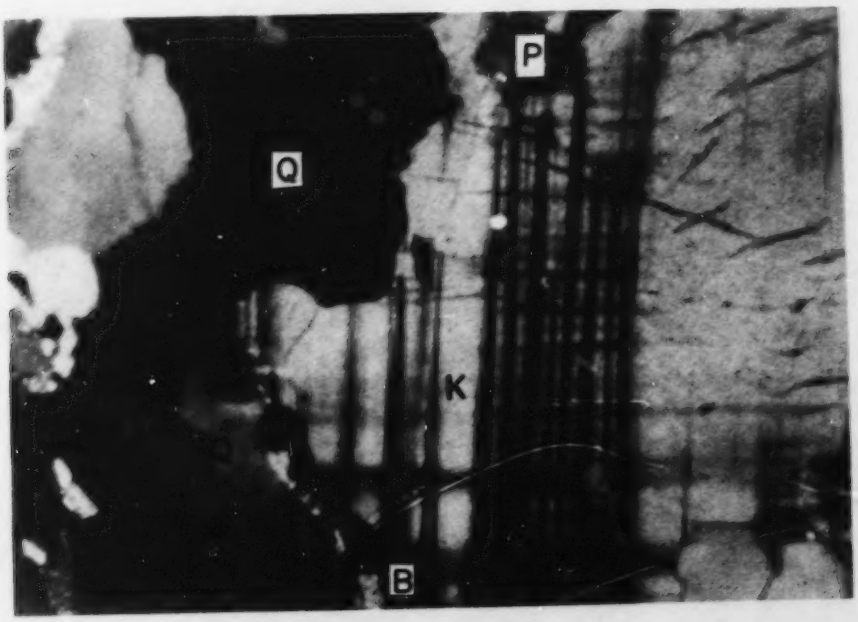

Plate 10. Sample URL-01 283.15 (B). Intragranular fractures in typical granitic K-feldspar. Crossed nicols. X20.

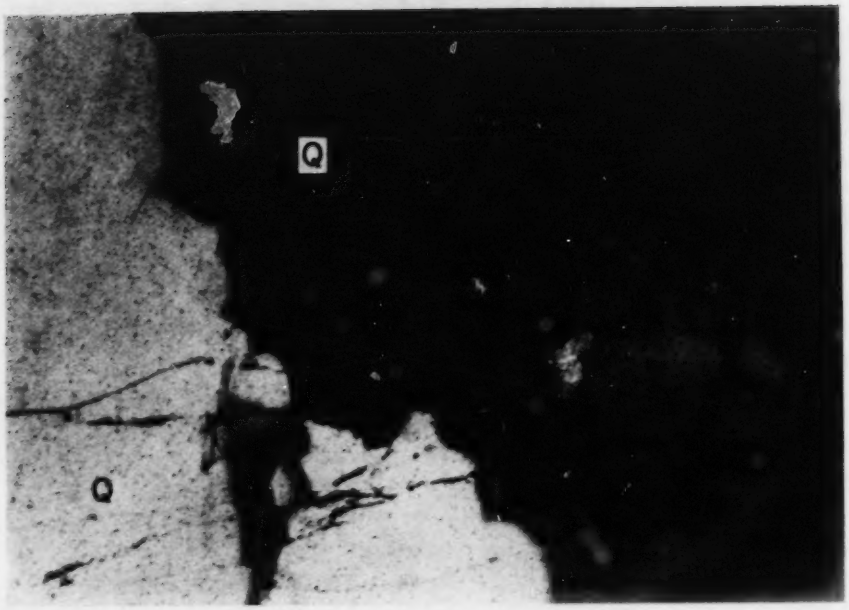

Plate 11. Sample URL-01 299.87 (H). Typical granitic texture. Crossed nicols. X20.

Plate 12. Sample URL-01 299.87 (B). Granitic texture. Crossed nicols. X20.

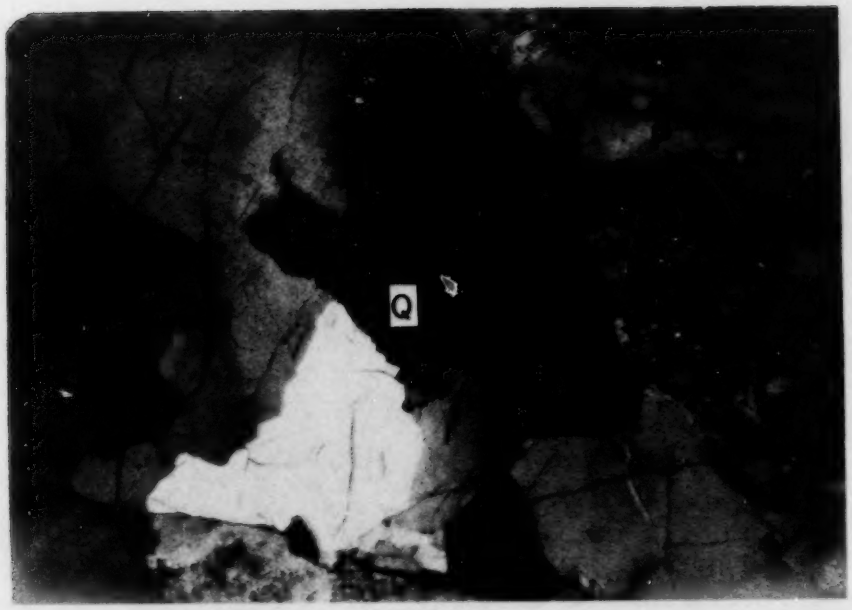

Plate 13. Sample URL-02 1081.16 (H). Multiple fractures in quartz and K-feldspar grains. Crossed nicols. X50.

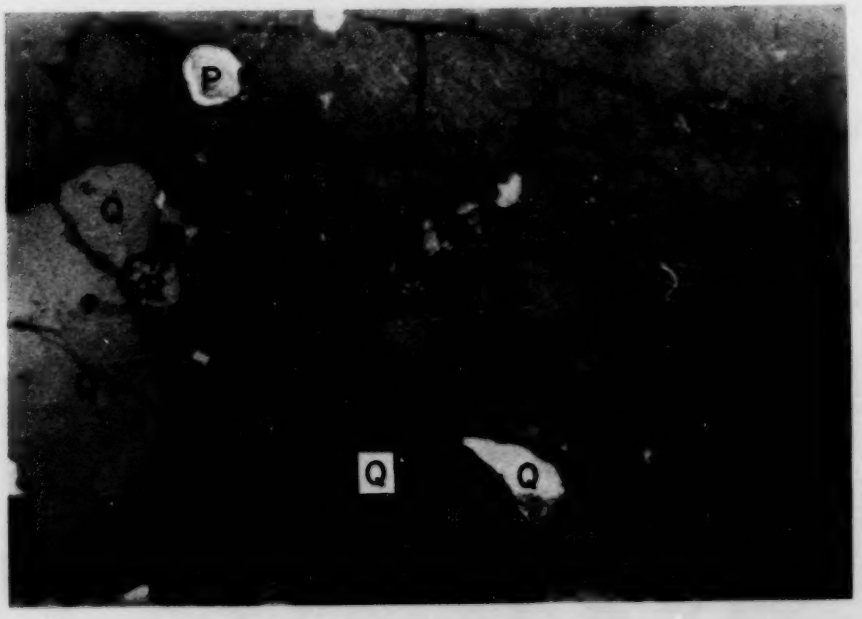

Plate 14. Sample URL-02 1081.16 (B). Multiple fractures in quartz, plagioclase and K-feldspar. Crossed nicols. X20.

Plate 15. Sample URL-02 1082.00 (B). A pair of intergranular fracture cut through K-feldspar and quartz grain. Crossed nicols. X20.

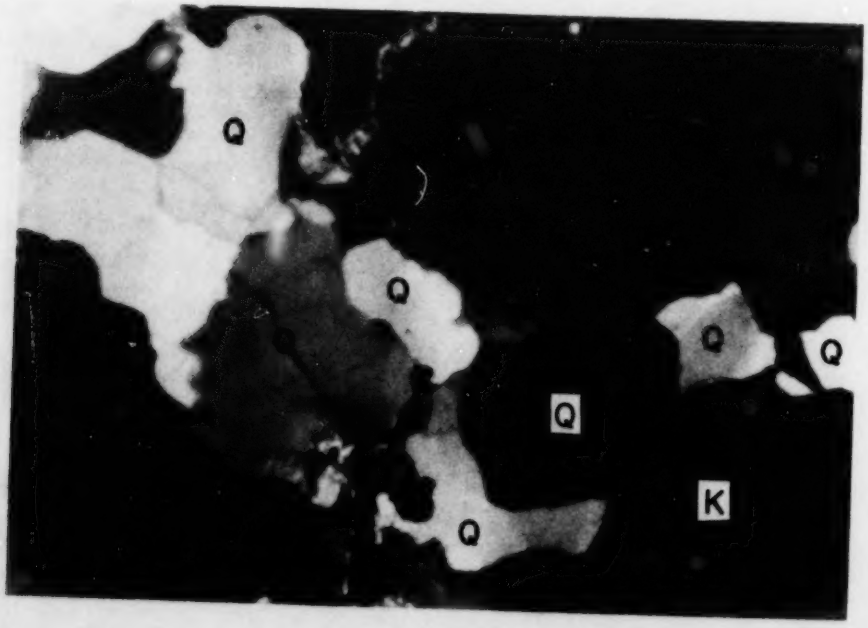

Plate 16. Sample URL-02 1082.54 (B). Typical granitic texture. Crossed nicols. X20.

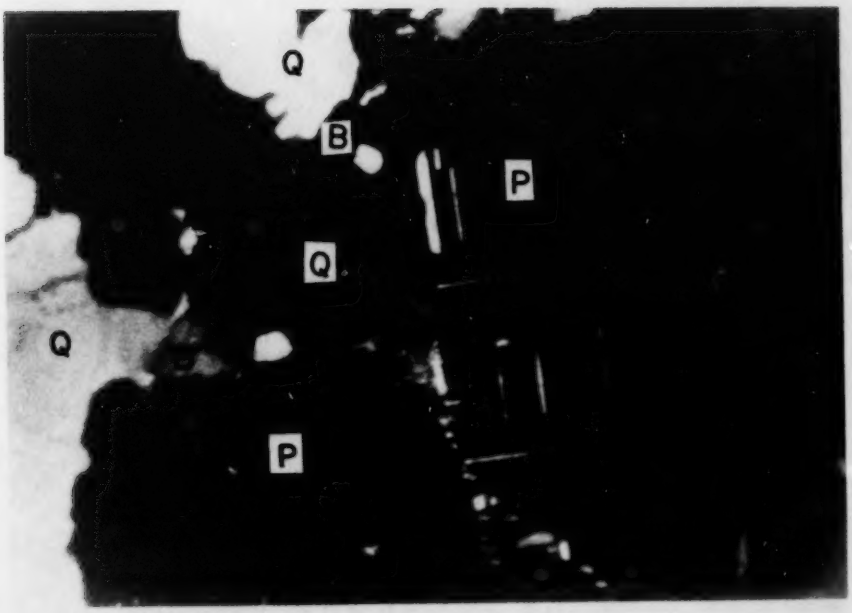

Plate 17. Sample URL-05 128.17 (B). Typical granitic texture. Crossed nicols. X20.

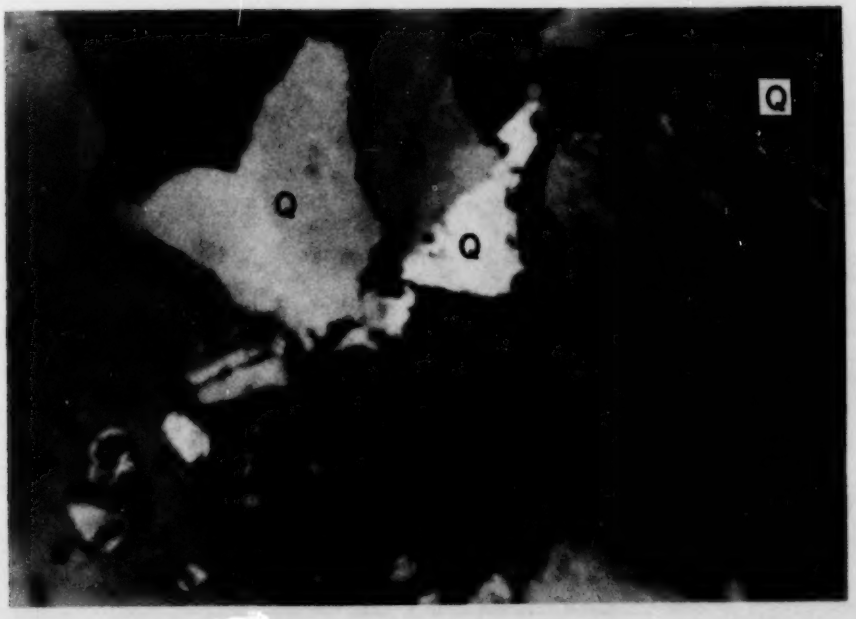

Plate 18. Sample URL-05 132.65 (B). Kinking bands on plagioclase grain. Typical granitic texture. Crossed nicols. X20.

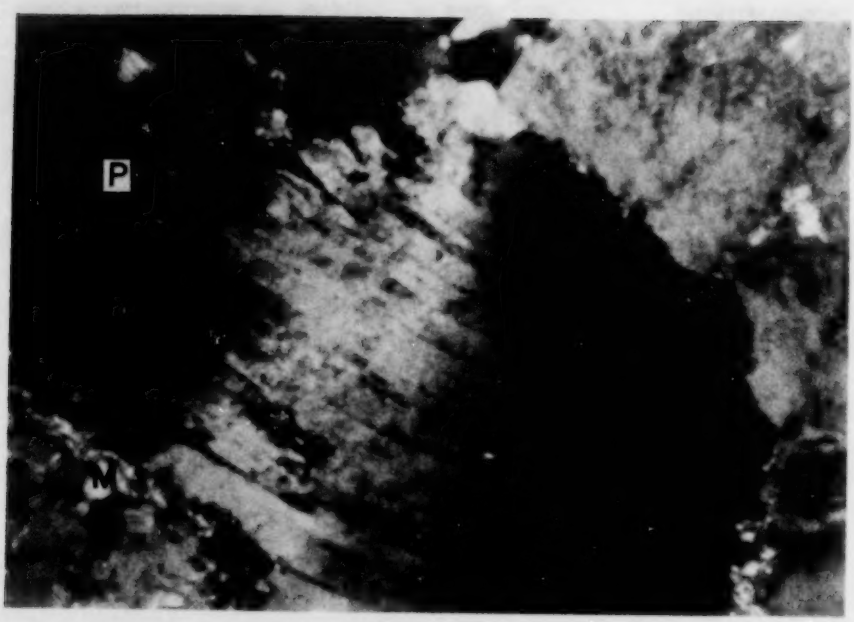

Plate 19. Sample URL-05 138.74 (B). Bending of plagioclase grains. Typical granitic texture. Crossed nicols. X20.

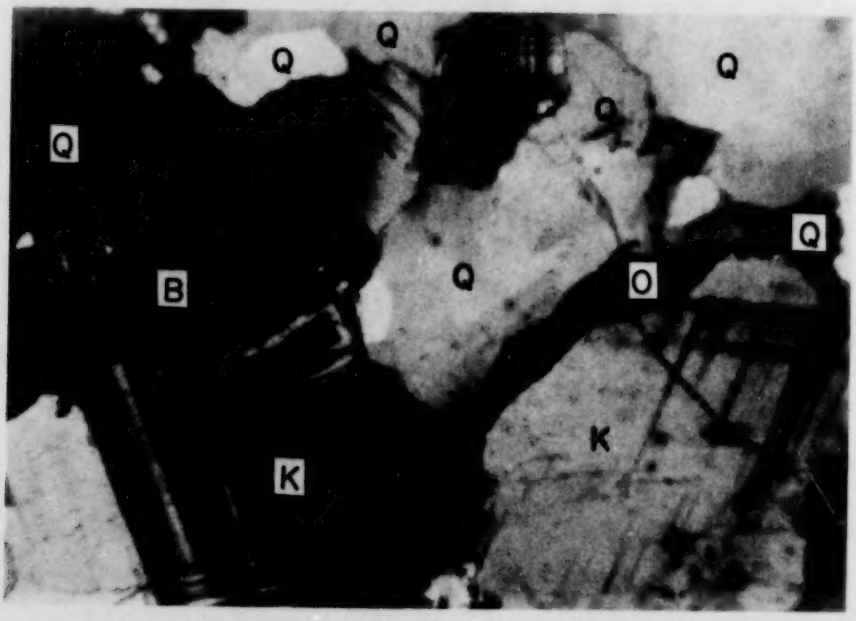

Plate 20. Sample URL-05 138.95 (B). Fractures in two directions at almost right angle in typical undulatory extinction quartz grains. Crossed nicols. X20.

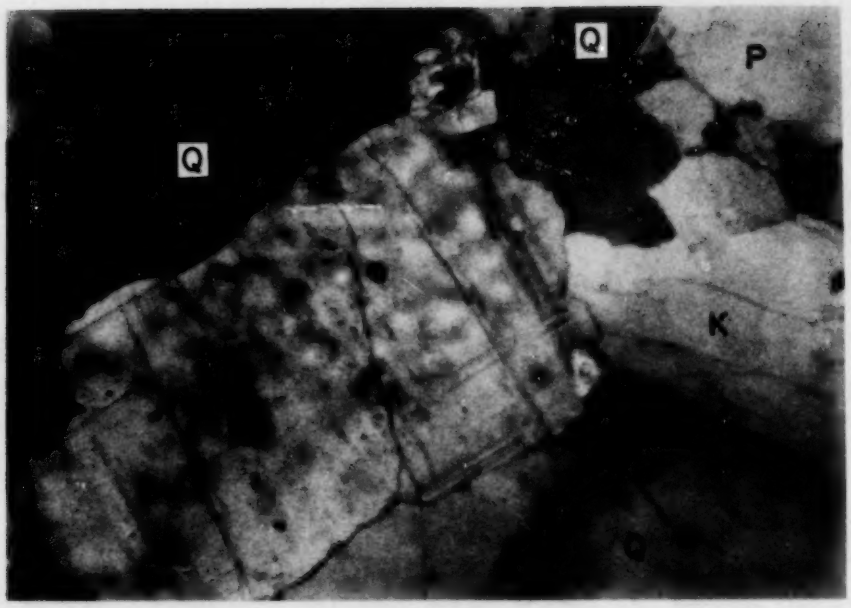

Plate 21. Sample URL-05 274.89 (B). Multiple sets of parallel of intragranular fractures on K-feldspar grain. Crossed nicols. X20.

Plate 22. Sample URL-05 279.00 (H). Intergranular fractures on quartz grains. Crossed nicols. X20.

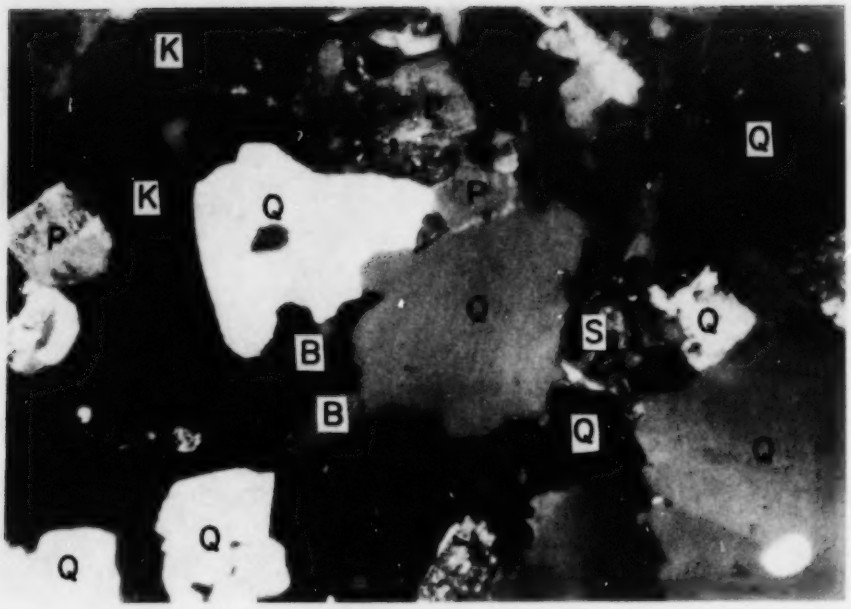

Plate 23. Sample URL-05 442.82 (B). Fine-grained granitic texture. High in mafic minerals. Crossed nicols. X20.

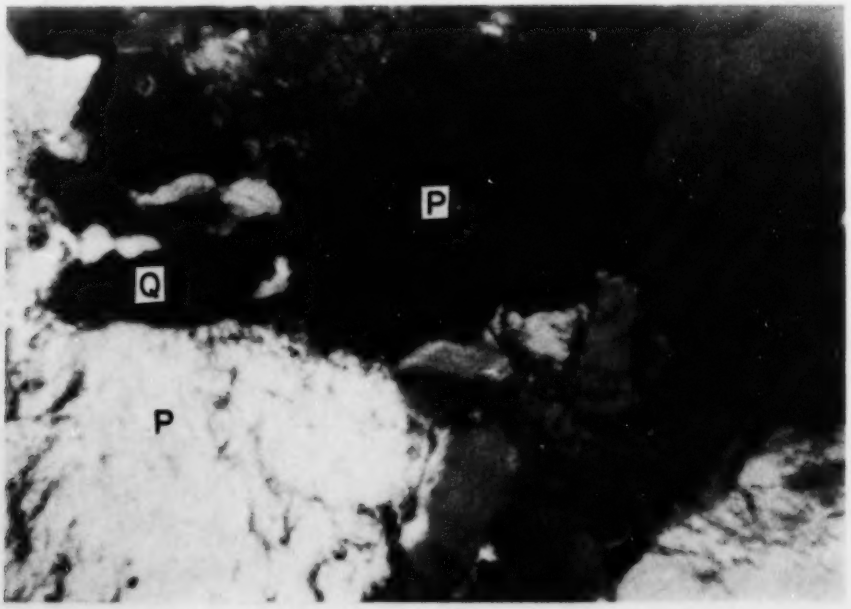

Plate 24. Sample URL-06 225.02 (B). Typical medium-grained granitic texture rock. Crossed nicols. X20.

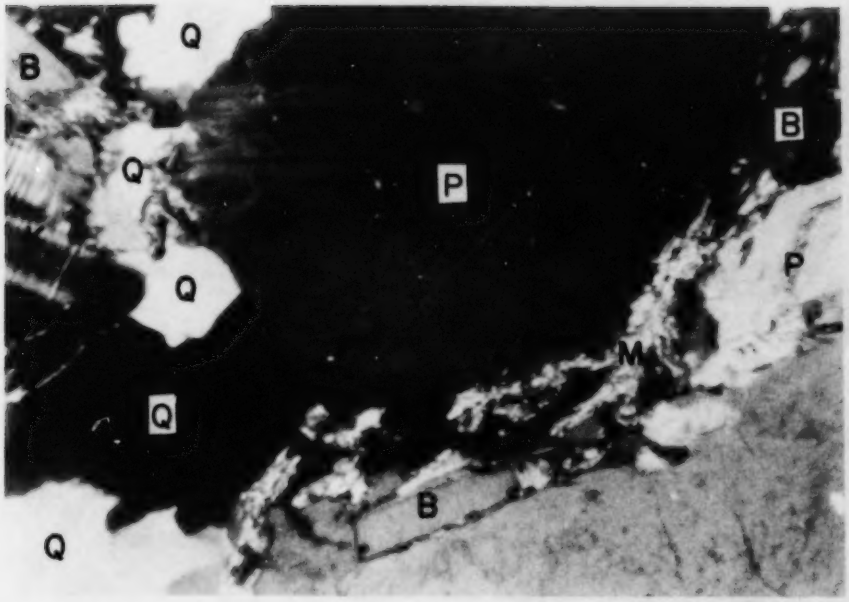

Plate 25. Sample URL-06 226.84 (B). Typical medium-grained granitic texture rock. Crossed nicols. X20.

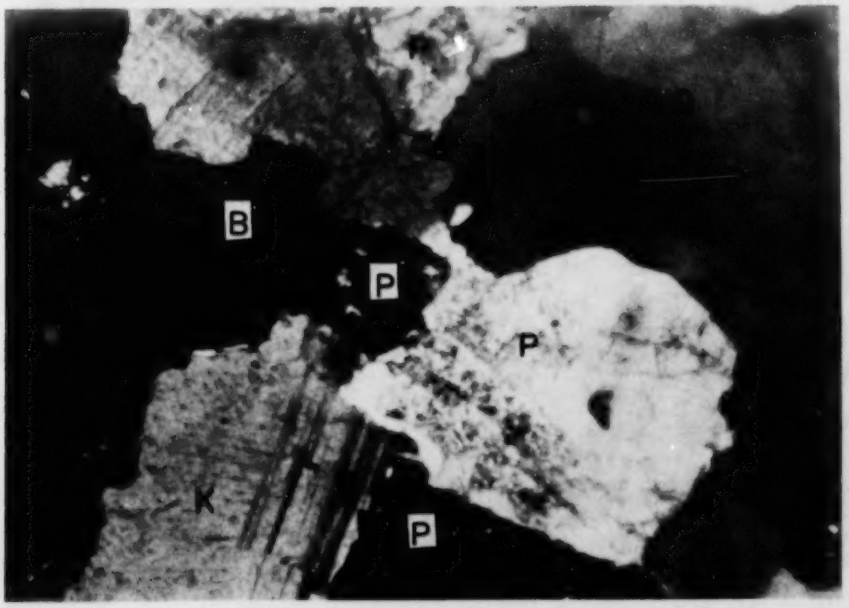

Plate 26. Sample URL-06 374.22 (B). Typical medium-grained granitic texture rock. Crossed nicols. X20.

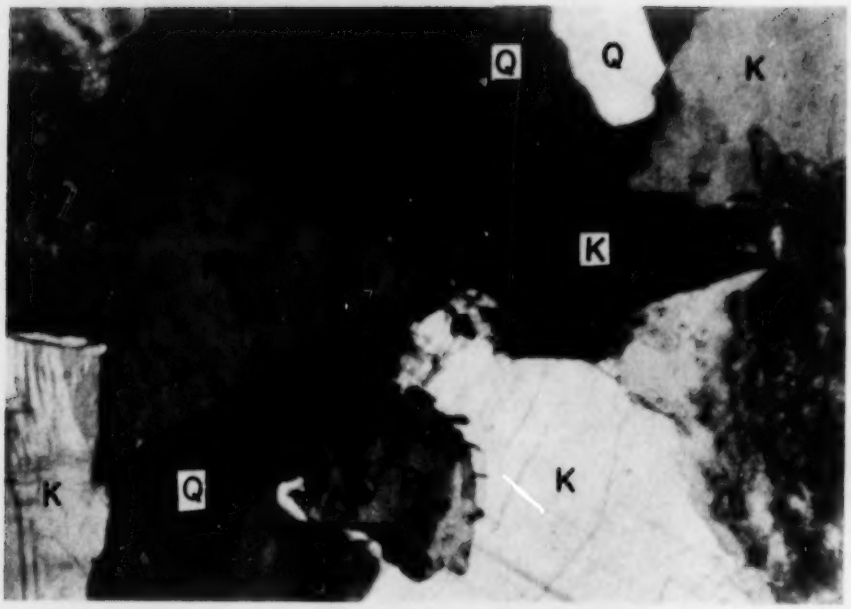

Plate 27. Sample URL-06 375.08 (B). Granitic texture. Crossed nicols. X20.

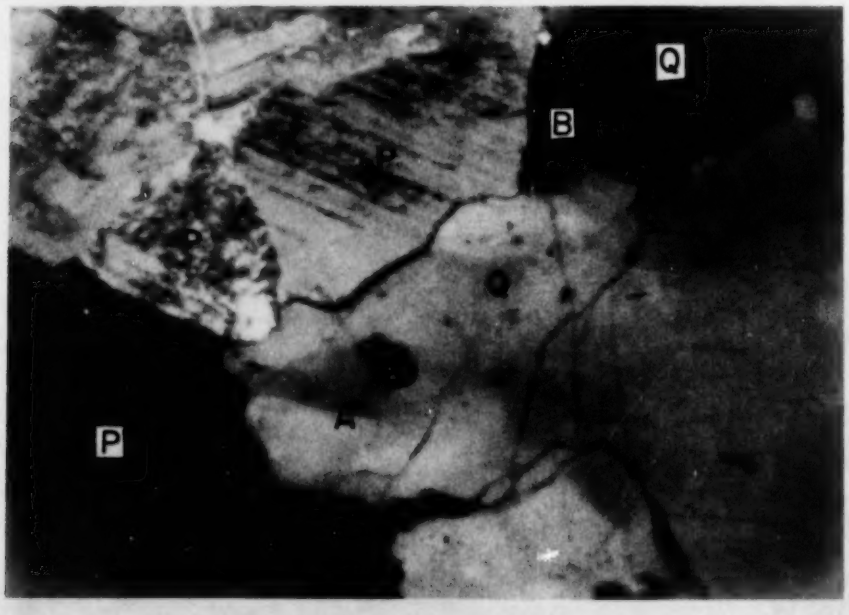

Plate 28. Sample URL-06 391.20 (B). Multiple fractures in undulatory extinction quartz grains. Crossed nicols. X20.

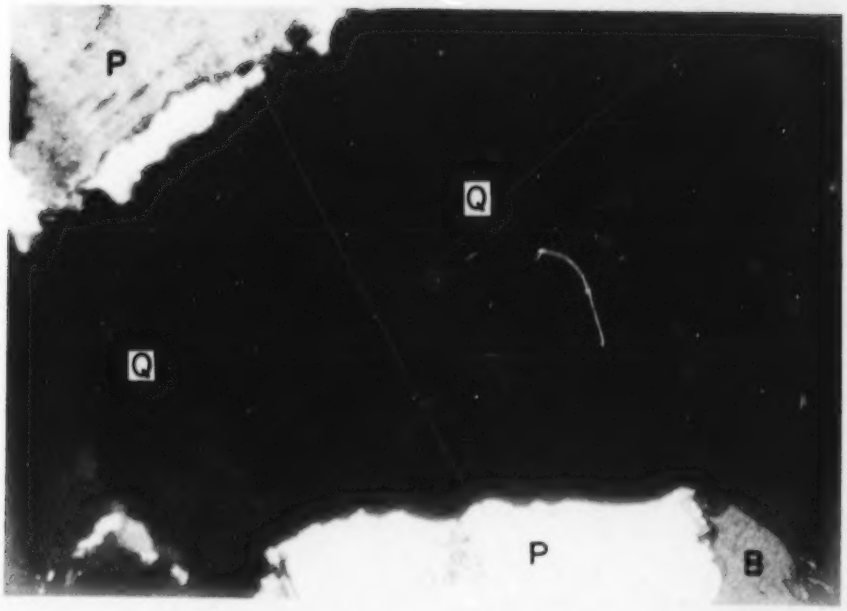

Plate 29. Sample URL-06 391.99 (B). Intragranular fractures on quartz grains. Crossed nicols. X20.

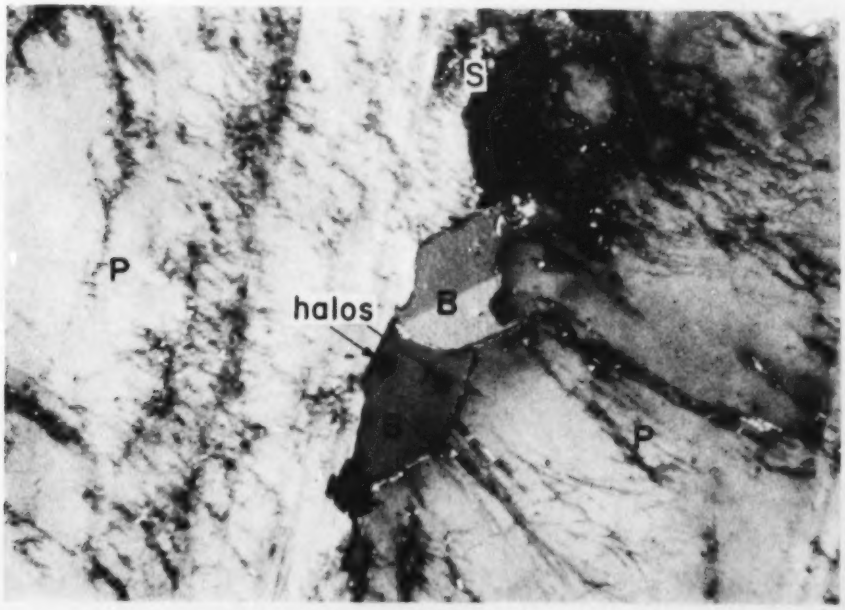

Plate 30. Sample URL-06 392.40 (B). Biotite with 'halos' texture. Granitic texture. Crossed nicols. X20.